[Name of the Document]	Request
[Reference No.]	0290734901
[Date of filing]	January 9, 2003
[Address]	Commissioner of Patent Office
[IPC]	G11B 07/26

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[Indication of Charge]

[Ledger Account No.]	011084
[Amount of Payment]	21,000 yen

[List of Document Filed]

[Document]	Specification	1
[Document]	Drawings	1
[Document]	Abstract	1

[General Power of Attorney ID No.] 0010570

[Necessity of Proof] Necessary

[NAME OF DOCUMENT] SPECIFICATION

[TITLE OF THE INVENTION] METHOD OF ADJUSTING EXPOSURE FOCUSING POSITION

[WHAT IS CLAIMED IS:]

[CLAIM 1] A method of adjusting a exposure focusing position in manufacture of an optical disc in which a surface of a substrate on which an inorganic resist layer is formed is irradiated with recording light corresponding to a recording signal pattern, said irradiated portion is removed by etching to obtain a master on which a convex and concave pattern is formed, and said master is used to obtain said optical disc on which said convex and concave pattern is formed, the method characterized by comprising:

irradiating, after a trial exposure is performed on a non-recording area of said resist layer, said exposed portion with light for evaluation to evaluate a recording signal characteristic of said resist layer from reflected light of said light for evaluation, and determining, based on a result of said evaluation, an optimum focus position of light for recording which is subsequently performed.

[CLAIM 2] The method of method of adjusting a exposure focusing position according to claim 1, characterized in that said inorganic resist layer is a resist layer containing an incomplete oxide of transition metals.

[CLAIM 3] The method of method of adjusting a exposure focusing position according to claim 1 or 2, characterized in that said predetermined area is an area other than an area irradiated with said light for recording.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[FIELD OF THE INVENTION]

The present invention relates to a method of adjusting an exposure focusing position for an optical disc.

[0002]

[BACKGROUND ART]

In recent years, an optical disc such as a DVD (Digital Versatile Disc)

has been used in a wide range of field as a recording medium.

This optical disc has a structure in which a minute concave and convex pattern such as pits and grooves representing information signals is formed on an optically transparent substrate made of polycarbonate or the like; a reflective film formed of a thin metal film of aluminum or the like is formed thereon; and further, a protective film is formed on the reflective film. This optical disc is manufactured through a well-known manufacturing process shown in Figs. 6 (for example, refer to Patent Document 1).

[0003]

First, a resist layer 91 constituted of a photosensitive photo-resist (organic resist) is uniformly formed on a glass substrate 90 whose surface has been planarized to obtain a resist substrate (Fig. 6(a)).

[0004]

Then, while relatively scanning a beam of recording laser light in a spiral form from an inner circumference portion to an outer circumference portion or from the outer circumference portion to the inner circumference portion on the resist layer 91 of the resist substrate, the recording laser light is turned ON/OFF corresponding to a recording signal pattern. As a result, the resist layer 91 is selectively exposed to the recording laser light (Fig.6(b)) to form a latent image corresponding to the information signal. Then, the resist layer 91 is developed to obtain a master 92 on which a predetermined convex and concave pattern is formed (Fig. 6(c)).

[0005]

Next, a nickel metal film is deposited on a surface of the concave and convex pattern of the resist substrate 92 by an electroforming method (Fig. 6(d)). This nickel metal film is exfoliated from the resist substrate 92 and subjected to a predetermined processing to obtain a molding stamper 93 onto which the concave and convex pattern of the resist substrate 92 is transcribed (Fig. 6(e)).

[0006]

Using the molding stamper 93, a resin disc 94 made of polycarbonate as

a thermoplastic resin material is molded by an injection molding method (Fig. 6(f)). Subsequently, a reflective film 95 made of aluminum alloy (Fig. 6(h)) and a protective film 96 are formed on the concave and convex surface of the resin disc 94 to obtain an optical disc (Fig. 6(i)).

[0007]

The optical disc manufactured as described above becomes a product after a quality inspection is performed, in which a jitter value (Jitter) is one of the items for measuring the quality. The jitter value indicates fluctuation of an RF signal in a direction of time axis when signal reproduction is performed and is an important item serving as a quality index of the reproduced signal of an optical disc. Further, since the jitter is affected by a fluctuation in dimensions of a concave portion (pit) in the concave and convex pattern formed in the optical disc, the value thereof has become a more important control item under the circumstances where the concave and convex pattern becomes minute due to an increase in capacity of optical discs of late.

[0008]

For the above reason, an optimum manufacturing condition is set for each step of the manufacturing process so as to suppress the fluctuation in the dimensions of the pits of the optical disc, and the jitter value is managed to fall within a predetermined range. Particularly, an exposure step that is a step in an upstream significantly affects formation of the pits. Specifically, since it is necessary to perform exposure with the recording laser light being focused on the surface of the resist layer of the resist substrate, a strict control for keeping a distance between an objective lens and the surface of the resist layer of the resist substrate (hereinafter, referred to as exposure focusing position) constant is required.

[0009]

Here, a method for adjusting the exposure focusing position in which a height of the resist substrate is fixed, reflected light from the resist substrate is visually monitored at a position at which it becomes confocal with the objective

lens, and a height of the objective lens is adjusted by operating a focus actuator so as to obtain the best spot shape of the reflected light has been generally used.

[Prior Art Document]

[Patent Document]

[0010]

[Patent Document 1] Japanese Patent Application Laid-open No. 2001-195791 (paragraphs [0002]-[0006])

[PROBLEMS TO BE SOLVED BY THE INVENTION]

[0011]

However, in the conventional adjusting method as described above, since differences between individuals occur in judgment as to whether the spot shape is good or not good, the exposure focusing point is fluctuated, which causes a fluctuation in signal characteristics of optical discs as end products.

In addition, since this focus adjustment needs a long optical system and a CCD camera for observing the reflected light at the confocal point, an optical system structure in an exposing apparatus has become complicated.

[0012]

Moreover, since the jitter value is obtained from the RF signal pattern at the time of signal reproduction and it is difficult to measure this value from the latent image of the resist layer after exposure or the convex and concave pattern after development, the measurement thereof has only been possible with respect to the optical disc at a stage of an end product (Fig. 6(i)) of the above described manufacturing process. Therefore, in a case where adjustment of the exposure focusing position is inappropriate, a series of labors and manufacturing time spent until then and also a product became useless. When a defect due to manufacturing condition of the exposing process occurs, its loss is significant.

[0013]

Further, since the jitter value obtained after the final process is fed back to the manufacturing process, a prompt correction of the manufacturing conditions has not been possible, either. Particularly, with respect to the

correction of the manufacturing condition in the exposing process, a long period of time has been required from the time when the relevant lot went through the exposing process until the time when the exposure condition corrected in accordance with feedback information from the final process of the lot is reflected. When a defect due to the manufacturing condition of the exposing process occurs, it also takes a long period of time to investigate the cause of defect, and thus it takes a further long amount of time before the correction to the condition is reflected in manufacturing, which has also resulted in an obstruction to the whole productivity.

[0014]

The present invention is made in view of the above problems in the conventional art, and aims at providing a method of adjusting an exposure focusing position that is capable of predicting and evaluating, in an exposing process, a recording signal characteristic (jitter value) of an optical disc from a recording signal characteristic in an exposed portion on a resist, and appropriately adjusting the exposure focusing position based on the evaluation result.

[0015]

[MEANS FOR SOLVING THE PROBLEMS]

The inventors have founded a phenomenon in which when adopting an exposing method of exposing a resist layer made of an inorganic resist material with laser light or the like to change a chemical state of the resist layer, a reflectance of light (amount of reflected light) changes correspondingly with the change of the chemical state of the inorganic resist material caused by this exposure, and have paid attention to and studied a diffraction phenomenon thereof, thereby attained the present invention.

Specifically, a method of adjusting an exposure focusing position according to the invention of claim 1 provided for solving the above problem is a method of adjusting a exposure focusing position in manufacture of an optical disc in which a surface of a substrate on which an inorganic resist layer is formed is irradiated with recording light corresponding to a recording signal pattern, said

irradiated portion is removed by etching to obtain a master on which a convex and concave pattern is formed, and said master is used to obtain said optical disc on which said convex and concave pattern is formed, the method characterized by including: irradiating, after a trial exposure is performed on a non-recording area of said resist layer, said exposed portion with light for evaluation to evaluate a recording signal characteristic of said resist layer from reflected light of said light for evaluation, and determining, based on a result of said evaluation, an optimum focus position of light for recording which is subsequently performed.

[0016]

With this method, since it is possible to determine, based on the recording signal characteristic in the exposed portion obtained by the trial exposure, whether a final product produced under the exposure condition is good or not good at a stage of the exposing process, it becomes possible to set immediately from this result the appropriate exposure focusing position for an area intended to be exposed for recording.

Hereupon, the evaluation of the recording signal characteristic of the resist layer means an evaluation of a relationship between the recording signal characteristic of the exposed master for the optical disc, that is, the jitter value of an RF signal pattern and the exposure focusing position, and it is desirable to select the exposure focusing position at which the jitter value becomes minimum. This is because the recording signal characteristic of the resist layer has a one-to one relationship with the recording signal characteristic (jitter value) of the optical disc.

Moreover, with respect to the RF signal pattern of the exposed master for the optical disc, since a modulation degree indicating an extent of diffraction of the reflected light of the exposed portion is also correlated with the recording signal characteristic (jitter value) of the optical disc, the exposure focusing position at which the modulation degree thereof becomes maximum may be selected.

It should be noted that, when a resist substrate made of an organic resist

material that is a conventional photosensitive resist material is exposed to perform a signal recording, the present invention can not be applied to since no difference occurs in the amount of reflected light between an area of a resist layer being exposed and an area thereof without being exposed, and what kind of signal is recorded cannot be confirmed at the stage of exposure.

[0017]

The method of adjusting an exposure focusing position according to the invention of claim 2 provided for solving the above problem is characterized in that, in the invention of claim 1, said inorganic resist layer is a resist layer containing an incomplete oxide of transition metals.

[0018]

The method of adjusting an exposure focusing position according to the invention of claim 2 provided for solving the above problem is characterized in that, in the invention of claim 1 or 2, said predetermined area is an area other than an area irradiated with said light for recording.

[0019]

With this method, since it is possible to determine, in the area where the quality of the optical disc is not affected, whether the end product under the condition of the exposure focusing position is good or not good at the stage immediately before performing the exposure processing in the exposing process, an evaluation can again be performed immediately even when the result of judgment turns to be NG, and the exposure focusing position can be corrected.

[BEST MODE FOR CARRYING OUT THE INVENTION]

[0020]

A description will be given on a method of manufacturing an optical disc using an inorganic resist material, which becomes a premise for a method for adjusting an exposure focusing position according to the present invention. As one of the manufacturing method, there is a method in which after forming on a substrate a resist layer made of a resist material containing an incomplete oxide of a transition metal that has a content of oxygen smaller than that of a

stoichiometric composition corresponding to the number of valences which the above transition metal can have, the resist layer is selectively exposed to correspond to a recording signal pattern and is developed to form a predetermined concave and convex pattern.

[0021]

Hereunder, an outline the manufacturing process is explained based on Figs. 1.

First, a resist layer 102 made of a resist material of a predetermined inorganic system is uniformly formed on a substrate 100 by a sputtering method (resist layer forming process, Fig. 1(a)). In addition, a predetermined intermediate layer 101 may be formed between the substrate 100 and the resist layer 102 in order to improve a recording sensitivity of the resist layer 102. Fig. 1(a) shows that state. Although a film thickness of the resist layer 102 can be set arbitrarily, it is desirable to be set within the range of 10 nm to 80 nm.

[0022]

Subsequently, the resist layer 102 is subjected to selective exposure corresponding to a signal pattern using an exposing apparatus provided with a known laser apparatus (resist layer exposing process, Fig. 1(b)). At this time, the incomplete oxide of the transition metal as the resist layer 102 absorbs an ultraviolet ray or visible light, and chemical property thereof changes by irradiating the ultraviolet ray or visible light.

Further, the resist layer 102 is developed to obtain a master 103 on which a predetermined convex and concave pattern is formed (resist layer developing process, Fig. 1(c)). In this case, the development is performed by utilizing a fact that there occurs a difference between an exposed portion and a non-exposed portion in etching speed with respect to acid or alkali aqueous solution though it is the inorganic resist, that is, a so-called selection ratio is obtained.

Processes shown if Figs. 1(d) to 1(i) are the same as those in a conventional manufacturing method.

[0023]

[Resist material]

A resist material employed as the above described resist layer 102 is an incomplete oxide of transition metals. Hereupon, incomplete oxide of transition metals means a compound in which an oxygen content is shifted in the direction of having less than that of a stoichiometric composition corresponding to the number of valences which the transition metal can take, in other words, the incomplete oxide is defined as the compound in which the oxygen content of the transition metal is less than that of the stoichiometric composition corresponding to the number of valences which the above transition metal can take. Accordingly, the resist layer 102 made of this material can absorb an optical energy of ultraviolet ray or visible light, which is transmitted in the state of complete oxide of the transition metal, so that recording a signal pattern can be performed utilizing a change in chemical state of the inorganic resist material.

[0024]

As specific examples of the transition metals constituting the resist material include Ti, V, Cr, Mn, Fe, Nb, Cu, Ni, Co, Mo, Ta, W, Zr, Ru, Ag, and the like. Among them, it is desirable to use Mo, W, Cr, Fe and Nb, and particularly it is desirable to use Mo and W from a viewpoint that a conspicuous chemical change can be obtained by applying ultraviolet ray or visible light.

[0025]

[Resist layer exposing process]

Hereinafter, a detailed description will be given on the resist layer exposure process in the above described manufacturing process, to which the present invention is directly related.

Fig. 2 shows a structure of the exposing apparatus used in the resist exposing process. This apparatus is provided with a beam source 11 which generates light to expose the resist layer and light for evaluation, for example, laser light. This exposing apparatus has a structure in which the laser light output from the beam source 11 is focused and irradiated on a resist layer of a substrate in which formation of the resist layer is completed (hereinafter, referred

to as resist substrate 15), through a collimator lens 12, grating 19, beam splitter 13 and objective lens 14. Further, this exposing apparatus has a structure in which light reflected from the resist substrate 15 is focused on a divided photodetector 18 through the beam splitter 13 and a condenser lens 17.

[0026]

When the exposed resist layer of the resist substrate 15 is irradiated with light for evaluation, the divided photodetector 18 detects the light reflected from the resist substrate 1, and an RF signal pattern is generated from the detection result in an arithmetic control circuit 1a. A focus actuator 1b performs, based on a predetermined value of the RF signal pattern, positioning of the objective lens 14 in a height direction before a recording exposure, that is, adjustment of an exposure focusing position. In reality, a predetermined focus bias voltage value is applied from the arithmetic control circuit 1a to the focus actuator 1b to perform adjustment of the exposure focusing position so as to move the objective lens 14 in the height direction. Further, the objective lens 14 is provided with a focus servo mechanism (not shown) to adjust a position of the objective lens 14 when performing a recording exposure such that a distance between the objective lens 14 and the resist substrate 1 is kept constant by a servo error signal.

[0027]

A turntable 16 is provided with a feed mechanism (not shown), so that the exposed position of the resist substrate 1 can be changed accurately. Further, in this exposing apparatus, a laser drive circuit (not shown) performs exposure based on a data signal and a signal of reflected light amount, while controlling the beam source 11. Furthermore, a central axis of the turntable 16 is provided with a spindle motor control system to set optimum spindle rotations and control the spindle motor based on a radial position and a desired linear velocity of an optical system.

[0028]

When exposing the resist layer for recording, first the resist substrate 15 is set on the turntable 16 of the exposing apparatus shown in Fig. 2 such that a

resist film formation surface is disposed upward.

Subsequently, while irradiating the laser light from the beam source 11 on the resist substrate 15 and also rotating the turntable 16 so that the resist substrate 15 mounted thereon is rotated, a spiral or concentric signal pattern from an inner circumference portion to an outer circumference portion or from the outer circumference portion to the inner circumference portion on a main surface of the resist substrate 15 is recorded on the resist layer by moving the resist substrate 15 in the radial direction together with the turntable 16. Specifically, when a light intensity of a beam spot condensed on the resist substrate 15 is equal to or larger than a certain degree, a change in chemical state occurs in the inorganic resist material on the resist substrate 15 so that a recording mark is formed, and therefore, in an actual exposure, an amount of light emitted from the beam source 11 is changed in accordance with a signal pattern for recording to form a pattern of the recording mark of the resist layer, so that a signal is recorded.

[0029]

[Signal characteristic of reflected light in exposed master for optical disc]

As described above, a chemical state of an area where signal recording has been performed in the inorganic resist layer is changed from the original chemical state (amorphous) of the inorganic resist material to a different chemical state (crystal). In the present invention, utilizing the fact that there occurs a difference in reflectance of light such as laser light due to the difference in the state thereof, a signal is taken out of the exposed master for the optical disc, in the same manner as a signal is taken out from an optical disc by an optical pickup, and a jitter value or a modulation degree of a recording signal of the exposed master for the optical disc is obtained from the signal. In other words, the difference in reflectance occurs between the areas with and without exposure due to the change of a chemical state of the exposed portion, and when laser light for evaluation is irradiated thereon, a change in an amount of reflected light occurs from a diffraction phenomenon generated due to the difference in reflectance, an

RF signal pattern is obtained therefrom, and furthermore, the jitter value and the modulation degree can be obtained from the RF signal pattern. It should be noted that the exposed master for the optical disc refers to the resist substrate after exposure and before development.

[0030]

Specifically, while laser light having lower power than that for exposure is irradiated from the beam source 11 to the resist substrate 15, the resist substrate 15 mounted on the turntable 16 is rotated and moved together with the turntable 16 in the radial direction, so that the exposed portion is relatively scanned and irradiated with the laser light. At this time, the irradiated laser light is reflected by the resist layer and the reflected light is detected by the photodetector 18 through the beam splitter 13 and the condenser lens 17 of the exposing apparatus. The RF signal pattern is taken out from the signal detected by the photodetector 18, and the jitter value or the modulation degree is obtained from the RF signal pattern.

[0031]

Fig. 3 shows a result obtained by exposing the resist substrate actually produced while changing the exposure focusing position thereof, taking out the RF signal pattern of the exposed master for the optical disc in each exposure focusing position, and obtaining the jitter value from the RF signal pattern. Here, silicon was used for the substrate. The exposed master for the optical disc was actually produced with laser light having 0.405 nm in wavelength using an incomplete oxide composed of a trivalent W and a trivalent Mo as a resist material. Recording and evaluation thereof were performed under a condition where a diameter of a beam spot of the recording laser light and a diameter of a beam spot of the evaluation laser light are the same and constant.

[0032]

In Fig. 3, it is recognized that when the focus bias voltage value, that is, the exposure focusing position, is changed, there exists the exposure focusing position at which the jitter value becomes the minimum. It should be noted that,

in Fig. 3, the focus bias voltage value is shown with setting the focus bias voltage value at which the jitter value becomes the minimum to 0 (zero) for convenience, and relative values therefrom on an adjusting dial scale in the plus (+) direction and a minus (-) direction are shown.

In evaluating the exposed master for the optical disc, it is considered that when the focus bias voltage value, that is, the exposure focusing position at which the jitter value becomes the minimum is used, a focal point of the recording laser light is best adjusted on the resist layer, that is, a quality of a light spot is best.

[0033]

Next, using the exposed master for the optical disc produced as shown in Fig. 3, the optical disc is produced in accordance with the manufacturing process in Fig. 1, and a jitter value of a reproduction signal from this disc was measured. The result of this measurement is shown in Fig. 4. Similar tendency to Fig. 3 is recognized also in Fig. 4, in which the exposure focusing position at which the jitter value becomes the minimum exists between the focus bias voltage value at the time of exposure (exposure focusing position) and the jitter value at the time of reproducing the optical disc, and the focus bias voltage value has been the same as that where the jitter value becomes the minimum in Fig. 3.

[0034]

Therefore, at a stage before development, it is possible to presume, from the jitter value of the exposed master, a jitter value of a recording signal of an optical disc which is produced from the master. In other words, if exposing is performed at the exposure focusing position at which a jitter value of the exposed master becomes the minimum, it is possible to obtain an optical disc having an excellent signal characteristic with the minimum jitter value. In this case, it is premised that manufacturing conditions in the resist layer developing process and subsequent processes are constant, or the like.

[0035]

Further, it is also possible to obtain, from the RF signal pattern of the exposed master for the optical disc, a modulation degree indicating an extent of

diffraction of reflected light from the exposed portion, and adjust the exposure focusing position based on the modulation degree. That is, as shown in Fig. 5, there exists the focus bias voltage value at the time of exposure (exposure focusing position) at which the modulation degree of the exposed master becomes the maximum, and the focus bias voltage value at which the jitter value of the optical disc produced in accordance with the manufacturing process in Fig. 1 using the exposed master for the optical disc produced as shown in Fig. 5 becomes the minimum at the time of reproduction has been the same as the focus bias voltage value at which the modulation degree becomes the maximum in Fig. 5.

Based on this relationship, if the exposure is performed at the exposure focusing position at which the modulation degree of the exposed master becomes the maximum, an optical disc having the excellent signal characteristic with the minimum jitter value can be obtained.

[0036]

[Method for adjusting the exposure focusing position]

The method of adjusting an exposure focusing position according to the present invention is a method to be performed at the stage of the exposing process in Fig. 1(b). This adjustment is performed utilizing a difference in reflectance of light such as laser light due to the difference in chemical state of the inorganic resist material in this exposing process, based on a result obtained by taking out a signal from the exposed master for the optical disc in the same manner as taking out a signal from an optical disc by an optical pickup. Hereinafter, an embodiment of the method for adjusting the exposure focusing position will be explained.

[0037]

In the resist layer exposing process in Fig. 1(b), a portion which does not serve as a recording area of an optical disc (a portion not used as a disc standard and hereinafter referred to as a trial exposure portion) such as an inner circumference portion or an outer circumference portion on the main surface of

the resist substrate is irradiated as a trial exposure with laser light of recording power, while the resist substrate 15 before the exposure is set on the turntable 16 of the exposing apparatus in Fig. 2 such that the resist film formation surface is disposed upward (s1). Specifically, by moving the resist substrate 15 together with the turntable 16 in the radial direction while irradiating the recording laser light on the resist substrate 15 from the beam source 11 and rotating the resist substrate 15 mounted on the turntable 16, the trial exposure portion is exposed to the light. At this time, the recording laser light is irradiated while the exposure focusing position is changed over a plurality of levels. At this time, in the incomplete oxide of transition metals as the resist layer, the chemical characteristic changes in an area irradiated with the recording laser light.

[0038]

Then, a trial exposure portion is irradiated with laser light for evaluation (s2).

Here, the rotation of the turntable 16 and the movement in the radial direction are similar to those in step s1. The focus position of the evaluation laser light is fixed and the power thereof that is made to approximately one thirties of that at the time of exposure is irradiated on the trial exposure portion.

[0039]

The laser light irradiated at step s2 is reflected by the resist layer and is detected by the photodetector 18 through the beam splitter 13 and the condenser lens 17 of the exposing apparatus (s3). Since the signal detected by the photodetector 18 is correlated with the reflectance of the resist layer, an RF signal pattern is taken out from the detected signal in the arithmetic control circuit 1a (s4).

Then, a jitter value or a modulation degree is detected from the RF signal pattern for each exposure focusing position changed at the time of trial exposure, and the exposure focusing position at which the jitter value becomes the minimum in the case of evaluating the jitter value, or the exposure focusing position at which the modulation degree becomes the maximum in the case of

evaluating the modulation degree is determined as the exposure focusing position for actual recording (s5).

[0040]

By irradiating the exposure focusing position determined at step s5 with laser light having a predetermined recording power, a selective exposure corresponding to the recording signal pattern is performed on the resist layer (s6).

By this method, the jitter value of the recording signal of the optical disc can be fallen within the standard range with high accuracy.

[0041]

Further, the exposure control method and the exposure evaluation method according to the present invention can also be applied to a method of exposing the above inorganic resist material with combined light of laser light and light of a mercury lamp. For example, such combination is conceivable, in which a red semiconductor laser having wavelength of 660 nm and an exposure by the mercury lamp having peaks around wavelengths of 185 nm, 254 nm and 405 nm are combined.

[0042]

[Practice example]

According to the method of adjusting an exposure focusing position according to the present invention, a resist master for an optical disc was actually produced using the incomplete oxide composed of a trivalent W and a trivalent Mo as the resist material to eventually produce an optical disc. Hereunder, this practice example is explained in detail with reference to Fig. 1.

[0043]

First, a silicon wafer was used as the substrate 100, and the intermediate layer made of an amorphous silicon having a film thickness of 80 nm was uniformly formed on the substrate 100 by a sputtering method. Then, the resist layer 102 made of incomplete oxide of W and Mo was uniformly formed thereon by a sputtering method (Fig. 1(a)). At this time, the sputtering was performed in an argon atmosphere using a sputter target made of incomplete oxide of W and

Mo. Then, when a deposited resist layer was analyzed using an EDX, an ratio of W and Mo in the incomplete oxide of W and Mo formed as the film was 80 : 20 and a content of oxygen was 60 atom%. Also, the film thickness of the resist layer was 55 nm. Note that from the result of analysis of electron diffraction by a transmissive electron microscope, the state of crystal of incomplete oxide WMoO before exposure was confirmed to be amorphous.

[0044]

The resist substrate on which the film formation of the resist layer had been completed was mounted on the turntable 16 of the exposing apparatus as shown in Fig. 2. Subsequently, the method for adjusting the exposure focusing position according to the present invention was performed. Specifically, while rotating the turntable 16 at desired rotations, a portion of the optical disc which does not serve as a recording area (a portion not used as a disc standard) such as the inner circumference portion or the outer circumference portion on the main surface of the resist substrate was irradiated with the recording laser light with changing the focus bias voltage value over a plurality of levels to perform the trial exposure, and subsequently the exposed portion was irradiated with laser light for the evaluation to take out the RF signal pattern and the jitter value thereof was evaluated.

[0045]

The exposure condition at that time is shown below.

- Exposing wavelength : 0.405 nm
- Numerical aperture NA of exposing optical system : 0.95
- Modulation : 17 PP
- Bit length : 112 nm
- Track pitch : 320 nm
- Linear velocity at the time of exposure : 4.92 m/s
- Write-in system : simplified write-in system similar to a phase change disc
- Recording laser light power : 6.0 mW

- Evaluation laser light Power : 0.2 mW

[0046]

As a result of the signal evaluation in the trial exposure portion, the focus bias voltage value at which the jitter value becomes the minimum was selected, which was set as the focus bias voltage value for the exposure of an actual exposure. With this setting, a position of the objective lens in the height direction was shifted and adjusted by the focus actuator so as to focus the recording laser light on the resist layer.

[0047]

Next, in a state where the optical system was fixed, the turntable was moved to a desired radial position by the feed mechanism provided on the turntable, and a surface of the resist layer was irradiated with the recording laser light under the above described exposure condition to expose the resist layer. Further, at this time the exposure was performed while continuously moving the turntable by a slight distance in the radial direction of the resist substrate with keeping the turntable rotated.

[0048]

After the above described exposure, predetermined development, electroforming, injection molding and formation of reflective and protective films were performed and the optical disc having a diameter of 12 cm was obtained. Note that a conventionally known technology was used in the processes for obtaining the optical disc from the exposed master. In the obtained optical disc, a pit having a length of 130 nm, a linear pit having a width of 149 nm and the like were formed corresponding to an actual signal pattern, and it was confirmed to be an optical disc having a recording capacity of 25 GB.

[0049]

Next, the above optical disc was read under the following condition, and the RF signal thereof was obtained as an eye pattern so as to perform a signal evaluation.

- Tracking servo : push-pull method

- Modulation : 17 PP
- Bit length : 112 nm
- Track pitch : 320 nm
- Read linear velocity : 4.92 m/s
- Read irradiation power : 0.4 mW

[0050]

As a result of the signal evaluation, the jitter value was 8.0% in the eye pattern on which conventional equalization processing was performed with respect to the eye pattern read out as it was, and the jitter value was 4.6% in the eye pattern on which limit equalization processing was performed, both of which have been sufficiently low values. In other words, it was confirmed that, according to the present invention, a favorable optical disc which has no difficulty in practical use as a ROM disc having the recording capacity of 25 GB can be obtained.

[0051]

[EFFECT OF THE INVENTION]

With the method of adjusting the exposure focusing position according to the present invention, at the stage of the exposing process, whether an end product to be manufactured with the exposure focusing position is good or not good can be judged based upon the recording signal characteristic (jitter value or modulation degree) in the exposed portion immediately after the trial exposure which is performed before the exposure processing, and therefore the exposure focusing position for an actual exposure can be appropriately determined immediately from that result. Further, at the stage immediately before the exposure processing of the exposing process, whether the end product to be manufactured under the condition of an exposure focusing position is good or not good can be judged in the area where the quality of the optical disc is not affected, and therefore even when the judgment result is NG, an evaluation can again be performed immediately to correct the exposure focusing position.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[Fig. 1] Manufacturing process diagrams of an optical disc to which a method for adjusting an exposure focusing position according to the present invention is applied;

[Fig. 2] A diagram schematically showing an exposing apparatus used in a resist layer exposing process to which the present invention is applied;

[Fig. 3] A graph showing a relationship between a focus bias voltage value at a time of exposure and a jitter value of an evaluation signal of an exposed master in the method for adjusting the exposure focusing position according to the present invention;

[Fig. 4] A graph showing a relationship between the focus bias voltage value at the time of exposure and a jitter value of a reproduction signal of an optical disc in the method for adjusting the exposure focusing position according to the present invention;

[Fig. 5] A graph showing a relationship between the focus bias voltage value at the time of exposure and a modulation degree of the evaluation signal of the exposed master in the method for adjusting the exposure focusing position according to the present invention; and

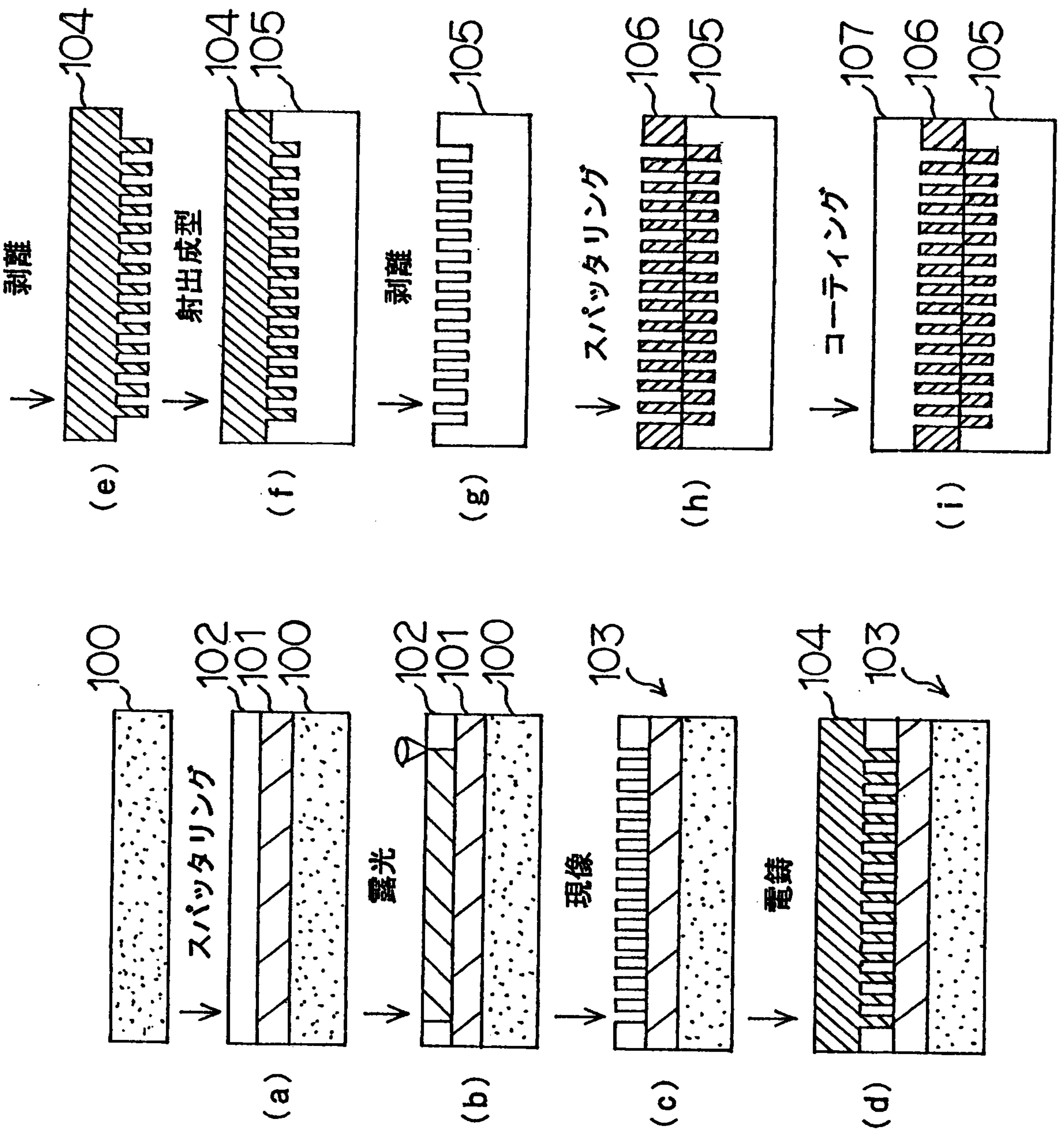
[Fig. 6] Manufacturing process diagrams of a conventional optical disc.

[DESCRIPTION OF REFERENCE NUMERALS]

1a arithmetic control circuit, 1b focus actuator, 11 beam source, 12 collimator lens, 13 beam splitter, 14 objective lens, 15 resist substrate, 16 turntable, 17 condenser lens, 18 divided photodetector, 19 grating, 90, 100 substrate, 101 intermediate layer, 91, 102 resist layer, 92, 103 master for optical disc, 94, 105 resin disc, 95, 106 reflective film, 96, 107 protective film

【書類名】図面

【図１】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露光
現像
電鋳
剥離
射出成型
剥離
スパッタリング
コーティング
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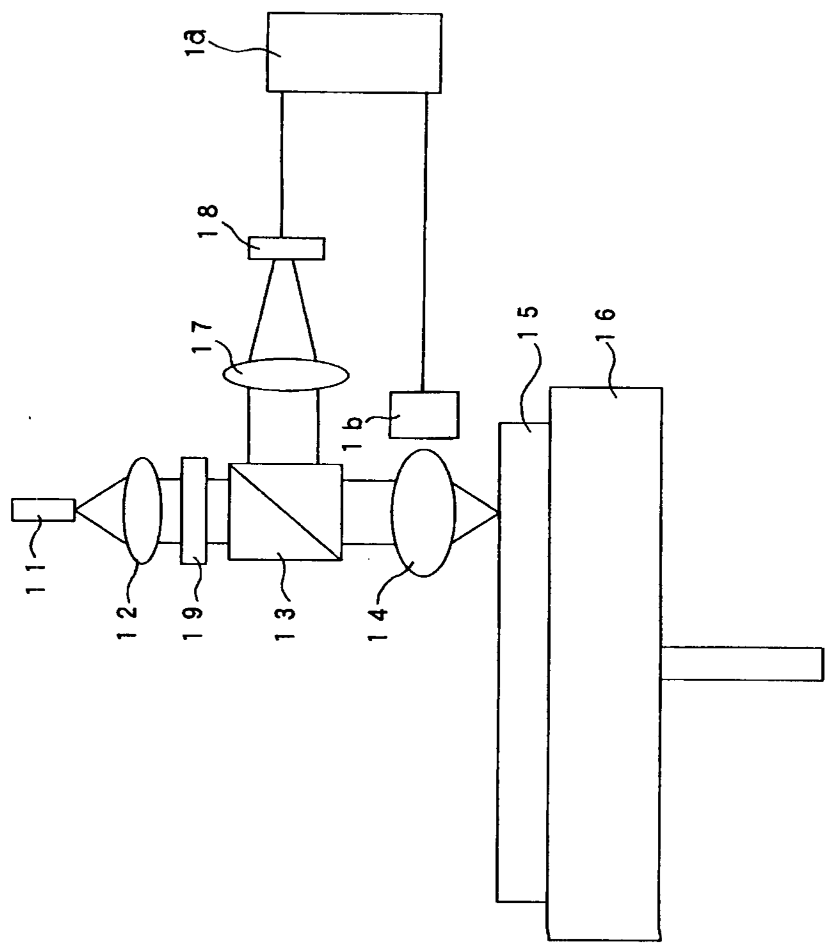
101
102
103
104
105
106
107

【図２】



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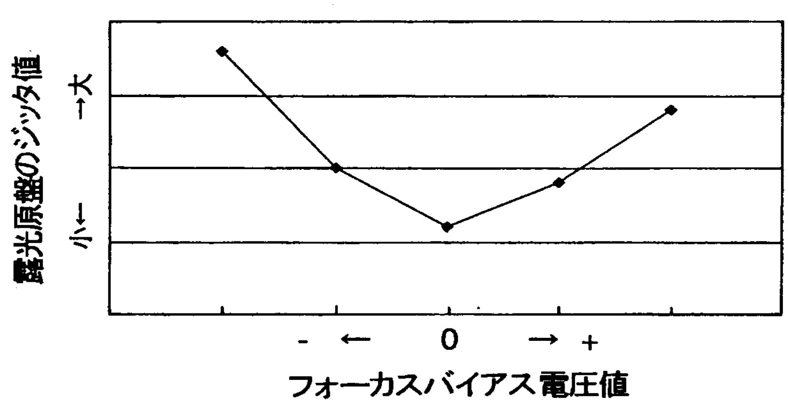

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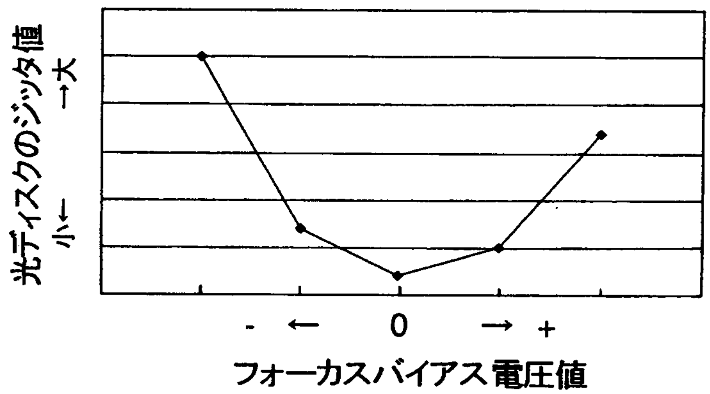

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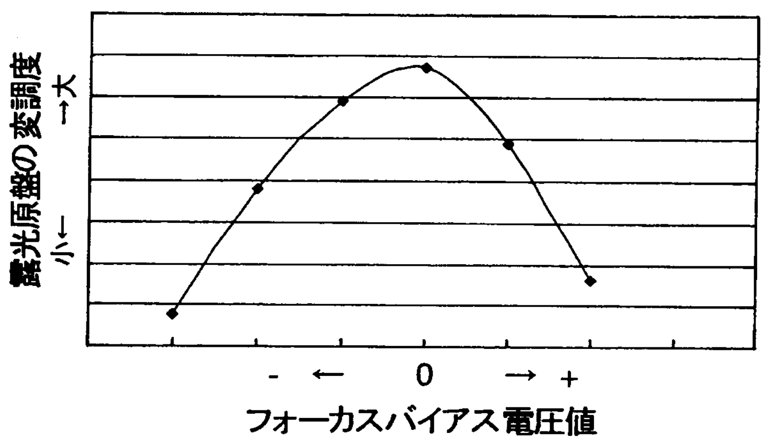

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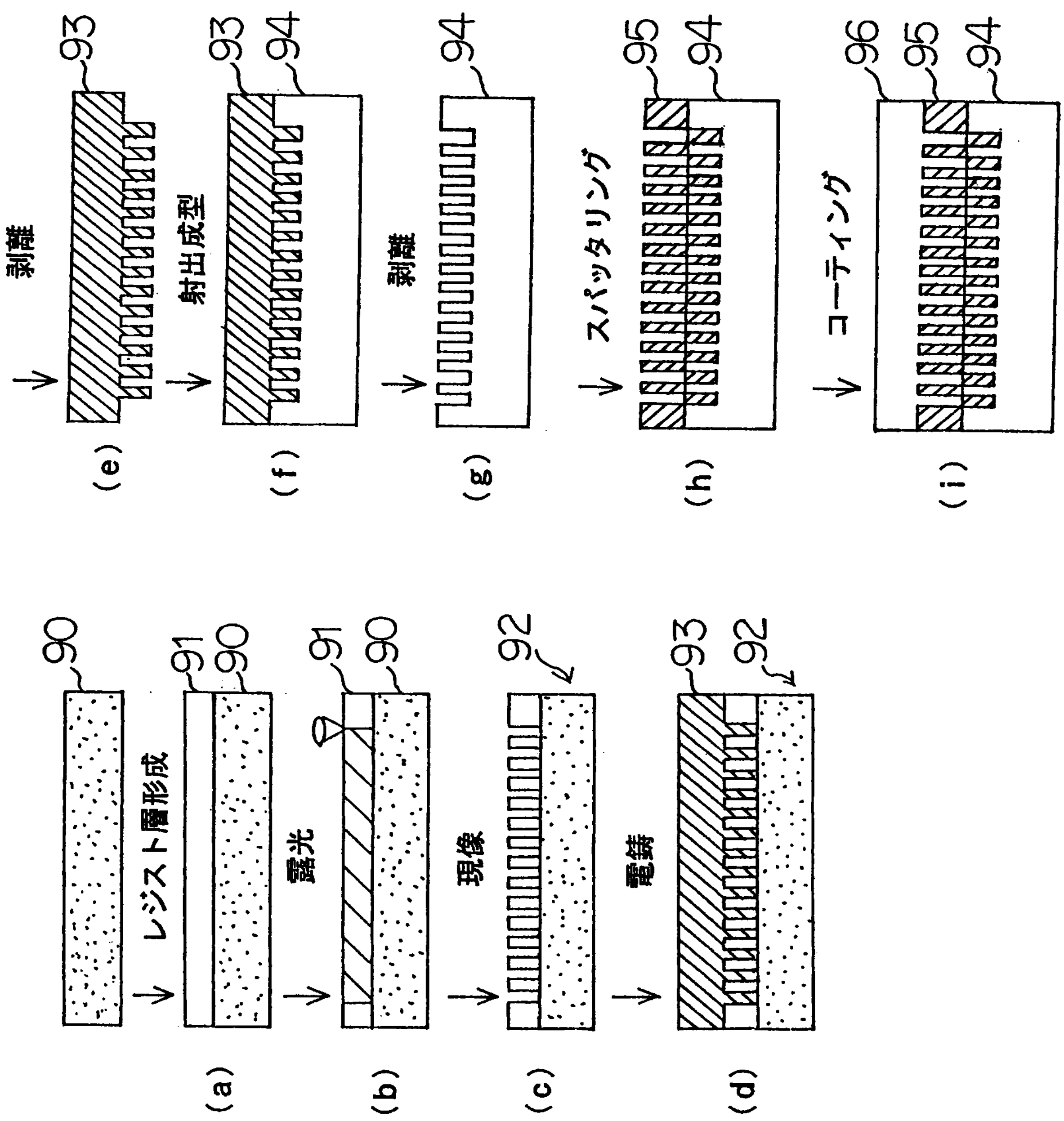
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(b)
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(i)
レジスト層形成
露光
現像
電鋳
剥離
射出成型
剥離
スパッタリング
コーティング
90
91
92
93
94
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【書類名】図面	[NAME OF DOCUMENT] DRAWINGS
【図１】	Fig. 1
スパッタリング	Sputtering
露光	Exposure
現像	Development
電鋳	Electroforming
剥離	Exfoliation
射出成型	Injection molding
コーティング	Coating
【図２】	Fig. 2
【図３】	Fig. 3
露光原盤のジッタ値	Jitter value of exposed master
フォーカスバイアス電圧値	Focus bias voltage value
【図４】	Fig. 4
光ディスクのジッタ値	Jitter value of optical disc
フォーカスバイアス電圧値	Focus bias voltage value
【図５】	Fig. 5
露光原盤の変調度	Modulation degree of exposed master
フォーカスバイアス電圧値	Focus bias voltage value
【図６】	Fig. 6
レジスト層形成	Formation of resist layer
露光	Exposure
現像	Development
電鋳	Electroforming
剥離	Exfoliation

射出成型	Injection molding
スパッタリング	Sputtering
コーティング	Coating

[NAME OF DOCUMENT] ABSTRACT
[SUMMARY]
[OBJECT]

To provide a method of adjusting an exposure focusing position that is capable of predicting and evaluating, in an exposing process, a recording signal characteristic (jitter value) of an optical disc from a recording signal characteristic in an exposed portion on a resist, and appropriately adjusting the exposure focusing position based on the evaluation result

[MEANS FOR SOLVING]

A method of adjusting a exposure focusing position in manufacture of an optical disc in which a substrate on which a resist layer containing incomplete oxide of transition metals in a surface thereof is formed is irradiated with recording light corresponding to a recording signal pattern, the irradiated portion is removed by etching to obtain a master on which a convex and concave pattern is formed, and the master is used to obtain said optical disc on which said convex and concave pattern is formed, the method including irradiating, after a trial exposure is performed on a non-recording area of the resist layer, the exposed portion with light for evaluation to evaluate a recording signal characteristic of the resist layer from reflected light of the light for evaluation, and determining, based on a result of the evaluation, an optimum focus position of light for recording which is subsequently performed.

[SELECTED DRAWING] Fig. 2